ARTIFICIAL INTELLIGENCE FOR CLIMATE CHANGE MITIGATION ROADMAP (SECOND EDITION)

DATA CENTER WATER USE

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Most modern data centers use water to cool the computer servers, which generate huge volumes of heat. The servers preferred by AI applications generate even more heat than standard servers and therefore use more water as a coolant. In addition, generating electricity for data centers often consumes water (Figure 15.5-1). Since many new data centers are being built in water-stressed areas, minimizing water usage for data centers is a priority in many locations.

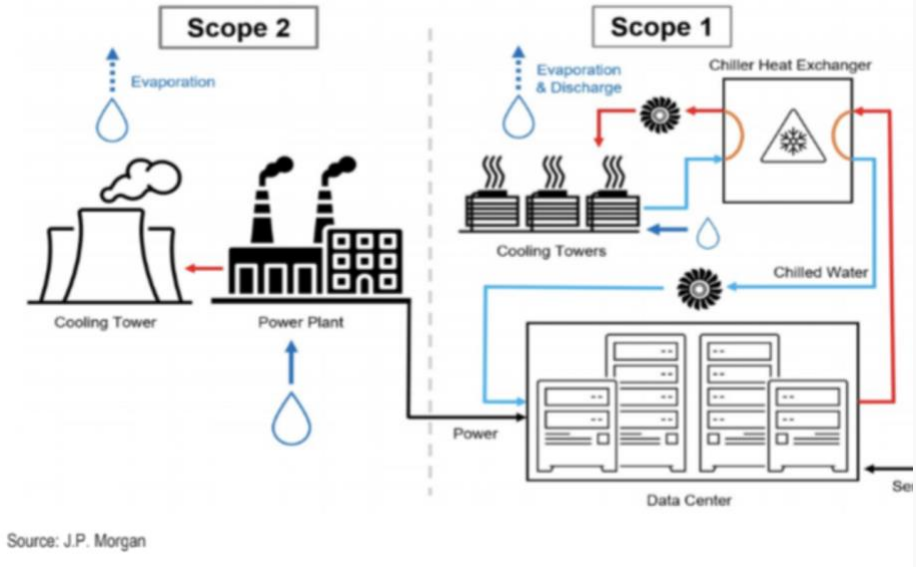

Figure 15.5-1. *Major sources of water consumption associated with data center operation and AI.*[1]

Magnitude

Data on the magnitude of water use by data centers are limited, as are projections about near-term consumption. Bluefield Research found that data centers consumed 292 million gallons per day (roughly 1.1 million m^3/d) globally in 2022 (Figure 15.5-2). They project global use will increase to roughly 450 million gallons/d (~1.7 million m^3/d)—a 5.5% annual increase.[1] (Only a portion of data center workloads, and therefore water use, is for AI applications.) In a 2023 paper, Li et al. project greater water consumption by 2027 (4.2–6.6 million m^3/d, depending largely on the cooling requirements for power systems and estimated growth rate).[2]

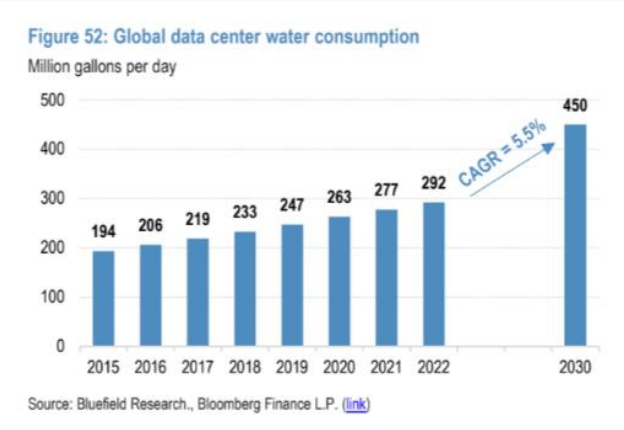

Figure 15.5-2. *Global water use for data centers. Source: JP Morgan Chase, based on original data from Bluefield Research*[1]

By way of comparison:

- The agricultural irrigation load of just the United States alone is ~140 billion gal/d,[3] or 300 times more than the 450 million gal/d forecast for global data center water use in 2030.
- The Amazon discharges ~4800 billion gal/d (almost 5 trillion/day),4 which is more than 10,000 times larger than the projected 2030 global data center water use.

Although 0.001% of one river could provide all the world's water consumption for all data centers, ultimately water is managed and consumed regionally. In water scarce regions, such as the Middle East or the western United States, local impacts could be substantial and unmanaged growth of data centers could lead to subsidence, local water shortages, and competition between agriculture and AI. In a 2021 paper on US data centers, Siddik et al. found that "one-fifth of data center servers' direct water footprint comes from moderately to highly water stressed watersheds, while nearly half of servers are fully or partially powered by power plants located within water stressed regions."[5]

Options and possible solutions

Many providers and operators of data centers are considering ways to reduce water consumption or water stress. For example, the computer maker Lenovo has begun to market a novel cooling system that significantly decreases water consumption.[6] Data-center builder and operator Nautilus Data Technologies typically operates on closed-loop cooling systems in sea water,[7] consuming no fresh water at all. In addition, some operators have begun exploring opportunities to use waste heat rather than rejecting it for cooling, including using it for district heating and running industrial processes (e.g., direct air capture).[8] And, of course, AI can be directly harnessed to optimize for minimal water consumption.

Policy options include mandatory water usage reporting, water efficiency standards, incentives for sustainable practices, water pricing mechanisms and water recycling mandates. (See Chapter 16 of this Roadmap.)

Data center water consumption will not be a major concern in many places but could be a significant concern in other locations. Water is a scarce resource and should be managed well in all circumstances. More data collection and research are needed.

Recommendations

1. *Data center operators and governments should collect and share data on water consumption to understand potential issues and determine risk. More and better data are needed to identify potential risks in terms of the magnitude and acuteness of community or environmental stresses.*
2. *Data center operators should explore potential pathways to reduce water consumption and mitigate risks. There are many promising, practical ways to manage water use and reduce total water consumption. The economic and technical viability of these options will vary by region. Especially in water stressed areas, data center operators should begin to track, review and explore options to responsibly and reasonably mitigate water consumption stresses and concerns.*
3. *National and local governments should consider policy options, including mandatory water usage reporting, water efficiency standards, incentives for sustainable practices, water pricing mechanisms and water recycling mandates.*

References

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